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APPLICATION FOR UNITED STATES PATENT

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Title: **TEMPORARY IMPLANT FOR USE AS AN ANCHOR IN THE MOUTH**

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SPECIFICATION

TEMPORARY IMPLANT FOR USE AS AN ANCHOR IN THE MOUTH

Field of the Invention

This invention relates to the use of an implant in the mouth as an anchor, and more particularly to a temporary implant positioned in a nonocclusal surface of the maxillary or mandibular jawbone.

Background of the Invention

In traditional tooth movement, orthodontic brackets are placed on the teeth, and the brackets are connected to one another using an orthodontic archwire. The orthodontic archwire transfers tooth-moving forces to certain teeth, using other teeth as anchors. However, this traditional method of tooth movement has several potential shortcomings or drawbacks associated with it. For example, in some patients, the tooth or teeth to be used as an

anchor may be missing. Furthermore, although a particular tooth may be serving as an anchor in generating an orthodontic force, in reality the teeth being moved also will exert a counter-force on this "anchor" tooth which may cause undesirable movement of the anchor tooth.

Therefore, in treating many orthodontic patients, it is desirable to stabilize certain teeth which otherwise would move due to the reactive forces created in the mouth. Traditionally, this tooth stabilization, or differential tooth movement, has been achieved by applying lower forces in the mouth or by utilizing several teeth as the anchor. However, when lower forces are applied, orthodontic treatment requires significantly more time, and when several teeth are used in combination as an anchor, the resulting tooth-moving response may be somewhat unpredictable. Orthodontists also have used headgear as a way of obtaining differential tooth movement. However, because the headgear is uncomfortable and highly visible, this device has low patient appeal and orthodontists have a difficult time gaining patient compliance.

More recently, it has been proposed to use a permanent implant embedded vertically in the occlusal surface of a jawbone to generate a tooth-moving force. For example, U.S. Patent No. 4,988,292 teaches the use of an abutment for orthodontic anchorage to a dental implant which is embedded vertically in an edentulous site in the jawbone. The abutment may be used to

support any one of a variety of orthodontic attachments, such as hooks and molar tubes. Furthermore, the abutment is intended to be part of a dental restoration plan for a patient who is molar-edentulous. Presumably, when the desired tooth movement has been achieved, the orthodontic abutment may be removed from the dental implant which is vertically embedded in the bone, and a prosthesis may be attached to the implant.

In addition, U.S. Patent No. 5,015,186 teaches an orthodontic prosthetic head having an orthodontic bracket, wherein the prosthetic head is removably attached to an artificial root implant embedded vertically in the occlusal surface of a jaw in place of a natural tooth. The '186 patent teaches that, because the implant fuses with bone, it can be used as an anchor for applying orthodontic forces on crooked teeth when posterior or back teeth cannot be used due to their absence or due to bone loss adjacent to the back teeth.

In addition to the permanent implants discussed above, it also has been proposed to use a temporary orthodontic implant positioned vertically in the occlusal surface of a jaw. More specifically, it has been proposed to use a retromolar implant as an intraoral anchor in mesially translating second and third molars to eliminate an edentulous first molar space, instead of filling the space with a denture or prosthesis, or using headgear as an extraoral anchor. Dr. W. Eugene Roberts, "Orthodontics as a Restorative

Option: Implant Anchorage to Close Posterior Extraction Sites", *Orthodontic Dialogue*, Vol. 7, No. 1, pp. 2-4 (Fall, 1994). This article teaches the placement of an anchorage implant about 5 mm distal to the third molar. After the implant has been affixed in the jawbone for about four months, it may be used as an anchor in stabilizing the pre-molar anterior to the extraction site, by forming a closed loop in the end of an archwire and securing the wire to the implant using a cover screw. At the end of active treatment, the implant may be removed under local anesthesia.

Although the implants discussed above provide an anchor in the mouth for selectively moving teeth, these implants have several limitations. For example, because each of these implants is embedded vertically into the occlusal surface of a jawbone, it must be adapted to withstand severe mastication (chewing) forces of up to about 70 kg. In order to withstand such forces, the implant must be fairly sizable, and must be embedded relatively deeply into the jawbone. Furthermore, because significant bone integration is required for implant stability, a clinician typically must wait from about three to nine months once the bare implant has been installed before the implant may be used in generating tooth moving forces. In addition, given the size of these implants, a clinician is extremely limited in selecting a site in the mouth for embedding the implant. These implants are designed to be embedded either at the site of a missing tooth or distal to the third

molar. Moreover, because these implants require a significant amount of bone integration for proper stability, it is relatively difficult to remove such implants after treatment.

Therefore, it would be beneficial to have a temporary implant for use as an anchor in the mouth that can be used immediately or within a few weeks of installation in the mouth. It also would be desirable to have an implant which does not require an edentulous site for implant placement. Furthermore, it would be advantageous to have an implant which does not require significant bone integration, and which may be removed relatively easily once treatment is completed. And in addition, it would be desirable to have an implant that is not particularly susceptible to the mastication forces normally encountered by the occlusal surfaces of the teeth and jawbones in the oral cavity.

Summary of the Invention

In its broadest aspects, the invention is directed to a temporary implant for use as an anchor in the mouth, as well as to a method of attaching the temporary implant to the maxillary or mandibular bone.

More particularly, the temporary implant includes an implant adapted to be temporarily affixed in a bone surface selected from the group consisting of the buccal, labial, lingual and palatal surfaces of the maxillary jawbone and the buccal, labial and lingual surfaces of the mandibular jawbone. Furthermore, when the implant

is affixed in the buccal, labial or lingual surface, it preferably is affixed at an angle of at least about 45° relative to the normal vertical orientation plane of the teeth (hereinafter "vertical orientation plane"). The implant also may include a securing section for releasably attaching an orthodontic appliance to the implant. When an orthodontic appliance is used in conjunction with the temporary implant, the orthodontic appliance may include a fastening section for releasably attaching the appliance to the implant. The appliance may be attached to the implant in a number of different ways. For example, the implant may include a threaded bore with the appliance having a corresponding threaded post, or the implant may include a threaded post, with the appliance having a threaded bore. Alternatively, the two components may snap-fit together or use any other suitable type of releasable attachment mechanism or device. Furthermore, if desired, the temporary implant and orthodontic appliance may be formed as a single component, with the appliance integral with the implant.

Various orthodontic appliances are suitable for use in conjunction with the temporary implant of the invention. For example, the temporary implant may be used in conjunction with a bracket, hook, ball joint, buccal tube, Herbst appliance, arch-expanding jackscrew or the like.

In a preferred form, the temporary implant includes a peripheral flange integral with the outer end (distal from the

implanted end), which may be grasped during attachment of an orthodontic appliance to the implant so as to prevent rotation of the implant in the bone once the implant has been temporarily positioned in the bone. If desired, the implant also may include a surface projection extending outwardly from the bone-contacting surface of the implant. The surface projection is adapted to form a slight mechanical interlock with the bone once the implant has been inserted into the bone and may be oriented in any of a number of different ways. For example, a projection aligned parallel to the longitudinal axis of the implant will inhibit relative rotation of the implant within the bone, while a projection aligned perpendicular to the longitudinal axis will inhibit the implant from being pulled out of the bone unintentionally. The surface projection may be of any form, with some examples including annular rings, screw threads, fins or the like.

In one particular embodiment of the temporary implant, the securing section includes a longitudinal bore which extends from the outer end (distal to the implanted end) of the implant to the inner end (proximal to the implanted end) of the implant, and which is adapted to receive a fastening section of an orthodontic appliance. The implant further includes a transverse slit extending longitudinally from the inner end of the implant, whereby insertion of the fastening section into the bore causes the diameter of a portion of the inner

end of the implant to expand, thereby securing the implant in the maxillary or mandibular bone.

The implant may be made of a metal, a ceramic, a bioresorbable material such as a polyglycolic acid derivative or poly L-lactate, or any combination of these materials. Preferred metals include titanium, titanium based alloys, nickel-titanium alloys, zirconium and zirconium alloys. In particular, shape memory alloys can be used which are adapted to be in a deformed orientation at ambient mouth temperature, thereby securing the implant to the maxillary or mandibular bone. Preferred ceramics include aluminum oxide, titanium nitride, titanium dioxide, zirconium oxide and calcium phosphate.

With respect to size, due to the placement of the implant in a nonocclusal bone surface of the jawbone and its lack of susceptibility to mastication forces, the implant may be relatively small. For example, the implant typically has a length of from about 2 mm to about 5 mm and a diameter of from about 0.5 mm to about 3 mm.

In the method of attaching the temporary implant, a portion of the implant is inserted into the buccal, labial, lingual or palatal bone surface. When the implant is inserted into the buccal, labial or lingual surface, it preferably is inserted into the bone at an angle of at least about 45° relative to the vertical orientation plane, whereby the implant may be used as a temporary anchor in the

mouth. Although the angle is preferably at least about 45°, more preferably, the implant is inserted into the bone at an angle between about 45° and 90° relative to the vertical orientation plane, with a most preferred angle being about 90°. Furthermore, in a preferred form, the implant is inserted about 2 mm to about 3 mm into the bone.

The temporary implant of this invention offers several benefits and advantages over the traditional implants embedded vertically in the occlusal surface of a jawbone. For example, because the temporary implant is not positioned in the occlusal surface, it is subjected to significantly lower chewing forces. Therefore, a smaller, much less invasive implant may be used if desired. Furthermore, it is believed that the implant only needs to be inserted about 2-3 mm into the bone for most treatments, and because little to no bone integration is required for most applications, the temporary implant is ready to use either immediately or within a few weeks after implantation. Also, because the implant is designed to have little bone integration, it is significantly easier to remove after treatment is completed. Additionally, because the temporary implant is installed in the buccal, labial, lingual or palatal surface of the maxillary jaw or the buccal, labial or lingual surface of the mandibular jawbone, as opposed to the occlusal surface of the bone, the clinician is not limited to placing the implant in an edentulous site.

These and other benefits and advantages will become readily apparent to persons skilled in the art upon review of the following Figures and detailed description of the invention.

Brief Description of the Drawings

Fig. 1 shows one embodiment of the temporary implant and a corresponding orthodontic appliance; the implant and appliance are adjacent to a hole drilled in a portion of a jawbone;

Fig. 2 shows an alternate embodiment of the temporary implant and corresponding orthodontic appliance;

Fig. 3 shows another embodiment of the temporary implant of the invention;

Fig. 4 shows yet another embodiment of a temporary implant formed of a shape-memory alloy and having four leg sections;

Fig. 4A is a cross-sectional view of the implant of Fig. 4 taken along line 4A-4A of Fig. 4;

Fig. 4B is a partial view of the implant of Fig. 4 shown in deformed position;

Fig. 5 illustrates another embodiment of the temporary implant in the shape of a tapered screw having threads.

Fig. 6 is a top view of one half of the mandibular arch, showing a temporary implant of the invention implanted on the lingual surface adjacent the site of a missing third molar;

Fig. 7 is a side view taken along line 7-7 of Fig. 6; ~~and~~

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Fig. 8 is a partial cross-section taken along line 8-8 of Fig. 7, showing the temporary implant embedded in the lingual surface of the mandibular jawbone;

Detailed Description of the Invention

The temporary implant according to the principles of the invention may be configured in any of a number of different ways and formed from any of a number of different materials, so long as the implant is adapted to be temporarily affixed in a nonocclusal surface of the maxillary or mandibular bone. For example, as shown in Fig. 1, one embodiment of the implant 10 includes a body 12 having an inner end 14, outer end 16 and securing section 18 for releasably attaching an orthodontic appliance 20 to the implant 10. In this particular embodiment, the securing section 18 is a threaded cylindrical bore 22 extending into the interior of the implant body 12 along the longitudinal axis from the implant outer end 16. The implant 10 shown further includes annular ridges 24 on the outer body surface 26 which are adapted to provide a slight mechanical retentive force with the surrounding bone 28 of the maxillary or mandibular jaw once the implant 10 has been placed into an opening 30 in the bone 28. In this particular implant, the outer end 16 includes an enlarged head 32 which is integral with the body portion 12 of the implant 10. Once the implant 10 has been inserted into the bone 28, this enlarged head 32 functions as a gripping surface which may be gripped by a pair of pliers or a dedicated implant-

gripping instrument when an orthodontic appliance, such as the orthodontic appliance 20 shown in Fig. 1 for example, is being releasably attached to or removed from the temporary implant 10. By gripping the installed implant in this fashion, various orthodontic appliances may be readily attached or removed without having the implant itself rotate within the bone. The orthodontic appliance 20 shown in Fig. 1 includes an orthodontic bracket 34 and a fastening section 36 integral with the bracket 34. In this particular embodiment, the fastening section 36 is a threaded post 38. Also, the bracket 34 includes a hinge cap 40 which may be snapped over the archwire slot 42 once an archwire (not shown) is placed in the slot 42.

As shown in Fig. 1, the temporary implant 10 is ready for insertion into a hole 30 drilled in a portion of the buccal, labial, lingual or palatal surface of the maxillary jawbone 28 or the buccal, labial or lingual surface of the mandibular jawbone 28. When the implant is inserted into a buccal, lingual or labial surface, it preferably is inserted at an angle of at least about 45° relative to a vertical orientation plane. As used herein, the term "vertical orientation plane" refers to the normal occlusal/gingival or vertical orientation plane of the teeth. Also, as used herein, "buccal" refers to surfaces facing the cheeks, "labial" refers to surfaces facing the lips, "palatal" refers to the surface of the roof of the mouth, and "lingual" refers to surfaces facing the tongue other than the palatal

surface. Furthermore, "occlusal" refers to those surfaces of the maxillary and mandibular jawbones which oppose each other when the jaws are closed, and from which the teeth extend in a normal dentition.

Because the temporary implants of this invention are for use in the nonocclusal surfaces (buccal, labial, lingual and palatal) of the maxillary and mandibular jawbones, they are not subject to the traditional heavy loads of as much as 70 kg or more which are placed on traditional occlusal implants due to chewing forces. Instead, loads on the temporary implant may reach a maximum of 10 kg, and more typically range from about 4 kg to about 5 kg. Furthermore, because the load bearing requirements for these temporary implants are significantly less than those needed for the traditional implants affixed in occlusal surfaces, the temporary implants only need to be inserted a very few millimeters into the bone. For example, traditional implants often are inserted approximately 5 mm into the occlusal surface of a maxillary or mandibular jawbone, whereas it is believed that a 2-3 mm implant insertion into the bone will provide a sufficient anchor for the temporary implants. In addition, because the temporary implant requires a significantly more shallow anchor depth, the implant may be removed relatively easily from the bone when the treatment period has ended.

Because a traditional occlusal surface implant is subjected to such large forces, a clinician must allow several months for the bone to thoroughly integrate around and into the surface of the implant before the implant may be used. However, because the inventive temporary implant is subjected to dramatically lower forces, significant bone integration usually is not required; and therefore, the temporary implant is available for use either immediately or within a very few weeks after insertion. Also, in order to achieve this bone integration, many traditional occlusal surface implants have an exterior surface which is highly porous or has other features to promote significant bone integration. And although the significant bone integration is required in order for such traditional implants to withstand the severe chewing forces, the bone integration makes it extremely difficult to remove such implants after treatment.

On the other hand, because of the relatively low forces exerted, the temporary implants of this invention require little to no bone integration, which is particularly advantageous in removing such implants after treatment. Whereas the traditional implants generally are made of materials designed to achieve some level of integration, the temporary implants do not have that limitation. Instead, the temporary implants are made of any material which is biocompatible and corrosion resistant. Typically, such implants are made of metal, ceramic, a bioresorbable material or a combination

thereof. If metal is used, the metal typically is titanium, a titanium based alloy, a nickel-titanium based alloy, zirconium, a zirconium alloy, a stainless steel or a combination thereof. If a ceramic is used in forming the implant, the ceramic typically is aluminum oxide, titanium nitride, titanium dioxide, zirconium oxide, or a hydroxyl-apatite based ceramic such as calcium phosphate. In addition, a bioresorbable material such as poly L-lactate or a polyglycolic acid derivative may be used, either alone or in combination with various ceramic and/or metallic materials in forming the temporary implant. Because bioresorbable materials essentially "dissolve" over time, they may be used to advantage to form an implant which does not have to be removed after treatment.

In most cases, where little to no bone integration is desired, it is preferred to have a smooth bone-contacting outer body surface. In some instances, however, it may be desirable to have some level of bone integration, in which case a different surface material may be used. Also, the outer body surface may be chemically or mechanically treated to increase or decrease surface roughness and bone integration. For example, the temporary implant may be selectively coated with an osteoinductive factor to obtain accelerated bone growth and fixation along selected areas of the implant. Nonlimiting examples of osteoinductive factors include bone morphogenetic protein and growth hormone. If a mechanical surface treatment is desired, the temporary implant may be provided

with an osteoconductive factor, which is any surface feature allowing bone to grow into the implant surface. For example, the implant may include surface regions which are roughened or porous or which have been coated with hydroxylapatite. If a porous surface is used, preferably the pore size ranges from about 100μ to about 500μ, more preferably from about 180μ to about 220μ.

In addition, the temporary implant may be coated with a material to inhibit or prevent infection. For example, the implant may be coated with an antibiotic or a basal laminar protein. If a basal laminar protein is used, it typically is coated onto the surfaces of the implant near the gum or palatal soft tissue. Such a coating stimulates adherence of soft tissue to the implant, thereby creating a biological seal to the oral cavity environment and preventing infectious agents from travelling into the bone.

Because the force placed on these temporary implants is significantly less than the force placed on traditional occlusal surface implants, the temporary implants may be made with smaller overall dimensions if desired. For example, for most applications, the length of the implant will range from about 2 mm to about 5 mm, and the diameter will range from about 0.5 mm to about 3 mm. A typical implant has a length of about 4 mm and a diameter of about 2 mm to about 2.5 mm. This ability to use an implant having dimensions which are smaller than those of traditional occlusal surface implants offers another significant benefit over such

traditional implants. Because these traditional implants are large and are designed to be oriented in an occlusal surface, they only may be placed in the jawbone at a site where there is no tooth. However, in the vast majority of applications, the inventive temporary implant may be sized so as to fit easily between the roots of adjacent teeth when inserted into a lingual, buccal or labial surface of the maxillary or mandibular bone.

Another embodiment of the temporary implant 110 is shown in Fig. 2. In this embodiment, the securing section 118 of the implant 110 is a threaded post 140 positioned at the outer end 116 of the implant 110, and the corresponding orthodontic appliance 120 includes a threaded bore 142 thereby allowing the appliance 120 to be releasably secured to the implant 110. In addition, the outer body surface 126 is substantially smooth.

Referring to Fig. 3, the implant 210 shown in this embodiment includes an outer body surface 226 which is generally smooth and contains no ridges. However, the longitudinal bore 222 in this implant 210 extends completely through the implant 210, from the outer end 216 to the inner end 214. Furthermore, the body portion 212 of the implant 210 includes a longitudinal cut 244 originating at the inner end 214 and extending part way along the length of the body 212. This embodiment includes a threaded cylindrical bore 222a having a uniform diameter which extends from the outer end 216 of the body 212 approximately half way down the

length of the implant 210. At this point, the threaded bore 222a changes into a tapered bore 222b with a cross-sectional diameter which gets increasingly smaller toward the inner end 214 of the implant 210. The orthodontic appliance 220 corresponding with this implant includes a two-part fastening section 236 for releasably attaching the appliance 220 to the implant 210. The first part of the fastening section is a threaded post 236a, and the second part is a stem 236b which is integral with the threaded post 236a. Once the implant 210 is inserted into a hole 230 drilled in the bone 228, the orthodontic appliance 220 is threaded into the implant 210. As the appliance 220 is threaded in, the stem 236b forces the two halves 246a, 246b of the lower body 248 outward, thereby releasably securing the implant 210 to the bone.

If desired, the shape-memory effect of a nickel/titanium based alloy may be used to advantage in the temporary implant. For example, the temporary implant may be formed of a shape-memory alloy having a transformation temperature which is below the temperatures normally experienced in the mouth. In this fashion, an implant may be easily placed in a hole drilled in the bone while the implant is below its transformation temperature and in a generally martensitic state. Then, as the implant warms up to the temperatures in the mouth, the shape-memory alloy will cross its transformation temperature into austenitic phase and return to its predetermined shape which secures the implant in the bone socket.

For example, this shape-memory effect can be used to effectively enlarge the outer diameter of the implant through expansion or bending of the implant. One example of an implant using a shape-memory alloy is shown in Figs. 4, 4A and 4B. In this particular embodiment, a cylindrical bore 322 extends longitudinally from the outer end 316 to the inner end 314 of the implant 310, with the bore 322 being threaded from the outer end 316 to the middle of the body 312. In addition, the portion of the implant body 312 extending from the middle of the body 312 to the inner end 314 is formed of a shape-memory alloy which is treated to have a predetermined shape substantially as shown in Fig. 4B. The particular implant 310 shown includes two longitudinal cuts 344a, 344b extending into the body portion 312 of the implant 310 from the inner end 314, with the cuts being generally perpendicular to one another. The implant 310 is inserted into a hole in the bone at a temperature below the transformation temperature of the shape-memory alloy, so that the implant 310 has the configuration substantially as shown in Fig. 4, and may be pressed into the hole in the bone relatively easily. Once the shape-memory alloy warms above its transformation temperature, it returns to its original expanded shape substantially as shown in Fig. 4B, thereby securing the implant 310 into the bone.

As mentioned briefly above, the temporary implant may be of any particular shape as long as it is adapted to be temporarily

affixed in a nonocclusal surface of the maxillary or mandibular bone. For example, the implant may have a cross-sectional shape other than a cylinder, and furthermore the diameter of the implant does not have to be uniform along its length. For example, the outer body surface of the implant may be conical in shape or may have sloped or tapered sidewalls which come together at the inner end of the implant. Referring to Fig. 5, a temporary implant 410 according to the principles of the invention is shown having tapered sidewalls 450. Furthermore, rather than having annular rings, a flat surface or some other surface formation, this particular embodiment has screw threads 452 on the outer body surface 426 allowing the implant 410 to be screwed into place in an opening in the maxillary or mandibular bone. Typically, a starter hole will be drilled into the bone prior to threading the implant into the opening. However, in certain embodiments, especially those that are conical in shape and small in diameter, it may be possible to insert the implant into the bone without initially drilling a hole.

Although the orthodontic appliance shown in Figs. 1-3 is an orthodontic bracket, any of a number of different orthodontic appliances may be releasably attached to the inventive temporary implant as well. For example, instead of the orthodontic bracket shown, the particular orthodontic appliance may be a hook, ball joint, buccal tube, or any other orthodontic or orthopedic device which may benefit from the use of the temporary implant as an anchor in

generating an orthodontic or orthopedic force in the mouth. A Herbst appliance and an arch-expanding jackscrew are just a few of the many additional types of devices which may be used with the temporary implant.

Also, while the securing section and fastening section have been shown having corresponding threads for releasably attaching an appliance to the temporary implant, the appliance may be attached using any one of a number of different fastening devices. For example, the appliance may be snap-fit onto the implant or if desired, the appliance and implant may be formed as a single integral unit, although with this latter embodiment, the implant must be removed in order to change to a different orthodontic appliance.

As mentioned briefly above, the temporary implant may be positioned anywhere along the palatal, lingual, buccal or labial surfaces of the maxillary or mandibular jawbones wherever a temporary anchor is needed in generating an orthodontic or orthopedic force. Furthermore, if desired, several temporary implants may be inserted in the mouth as needed. In some applications, the temporary implant may be used as an anchor to prevent tooth movement. For example, the insert may exert a force on a tooth that is countering another equal and opposite orthodontic force on that same tooth. In other applications, the temporary implant may be used to move a tooth or several teeth, in virtually

any direction desired. In still other applications, the implant may be used to exert bone-to-bone, or orthopedic forces.

As an example of an orthodontic application, referring to Figs. 6-8, the temporary implant 10 of Fig. 1 is shown as an anchor in the distalization of the first and second molars 60, 62 on the right side of the mandibular jawbone 64. The temporary implant 10 is inserted into a hole 30 drilled in the lingual surface 66 of the mandibular bone 64 and a lingual bracket 34 having a fastening section (not shown) and a hinge cap 40 is releasably attached to the implant 10. In addition, a conventional lingual bracket 68 is affixed to each of the first and second molars 60, 62, and an archwire 70 is aligned in the archwire slot of each of the three brackets. In order to move the teeth distally, an expanding coil spring 74 is positioned on the archwire 70 distal to the temporary implant 10 and bracket 34 attached to the implant 10.

By way of example, the temporary implant also may be used to secure an "onplant" to a buccal, labial, lingual or palatal bone surface, thereby rendering the onplant available for substantially immediate use (i.e., on the order of minutes, hours, days or a few weeks after installation, depending upon the particular forces to be exerted on the implant). An "onplant" is a temporary orthodontic anchoring disk or plate having a bone-facing surface that is secured to bone using an osteoconductive factor such as hydroxylapatite which is disposed on at least part of the bone-facing

surface. Details regarding the onplant may be found in Michael S. Block et al., "A New Device for Absolute Anchorage for Orthodontics", *American Journal of Orthodontics and Dentofacial Orthopedics*, pp. 251-258 (March, 1995), which is incorporated herein in its entirety by reference.

One of the limitations of the onplant is that it requires at least 10 to 12 weeks of healing time before it may be used. However, using the temporary implant of the present invention, the onplant may be made available for immediate use. For example, the onplant disk or plate may be formed with a hole or holes, i.e., a passage or passages, for receiving one or more of the inventive temporary implants, with the hole(s)/passage(s) typically generally perpendicular to the bone-facing surface. The implant then is passed through the hole in the onplant and into a hole formed in a bone surface, thereby securing the onplant for immediate use. In this application, the temporary implant preferably is made of a bioresorbable material. Therefore, although the implant provides sufficient strength, it "dissolves" over time, leaving only the onplant device secured to the bone surface by bone integration into the osteoconductive surfaces of the onplant disk.

The temporary implants of the present invention also may be used to exert a bone-moving force without having to transfer that force through the teeth. For example, when a patient has a regressive lower jaw, one of the traditional methods of treatment is

to attach a Herbst appliance to the teeth. One end of the appliance is attached to a tooth extending down from the maxillary arch, and the other end of the Herbst appliance is attached to a mesially positioned tooth extending upward from the mandibular arch. Although this appliance moves the lower jaw forward, it has the undesirable effect of moving the teeth to which it is attached as well. With the inventive temporary implant, however, an implant may be positioned in each of the maxillary and mandibular arches, and the Herbst appliance may be connected directly to each of the implants, thereby generating a direct bone-to-bone force. Another illustration of the benefit of the inventive temporary implant is in the expansion of an arch. In one traditional method of arch expansion, a jackscrew is attached to four teeth on a given arch. The jackscrew then exerts an expanding force on the teeth, and the teeth translate this force to the bone, which has the undesirable effect of moving the teeth. With the temporary implants, the jackscrew may be attached directly to the implants temporarily affixed in the bone of the arch being expanded, thereby avoiding unwanted tooth movement.

While the temporary implant has been described in detail above with respect to a few embodiments and uses, the scope of the invention is to be determined by the following claims.